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STATIONARY DIESEL ENGINE-GENERATOR SET ACCEPTANCE TESTING PROCE--ETC(U)
MAR 77 E M TAKEMORI , S W LEE, M A GAZDA

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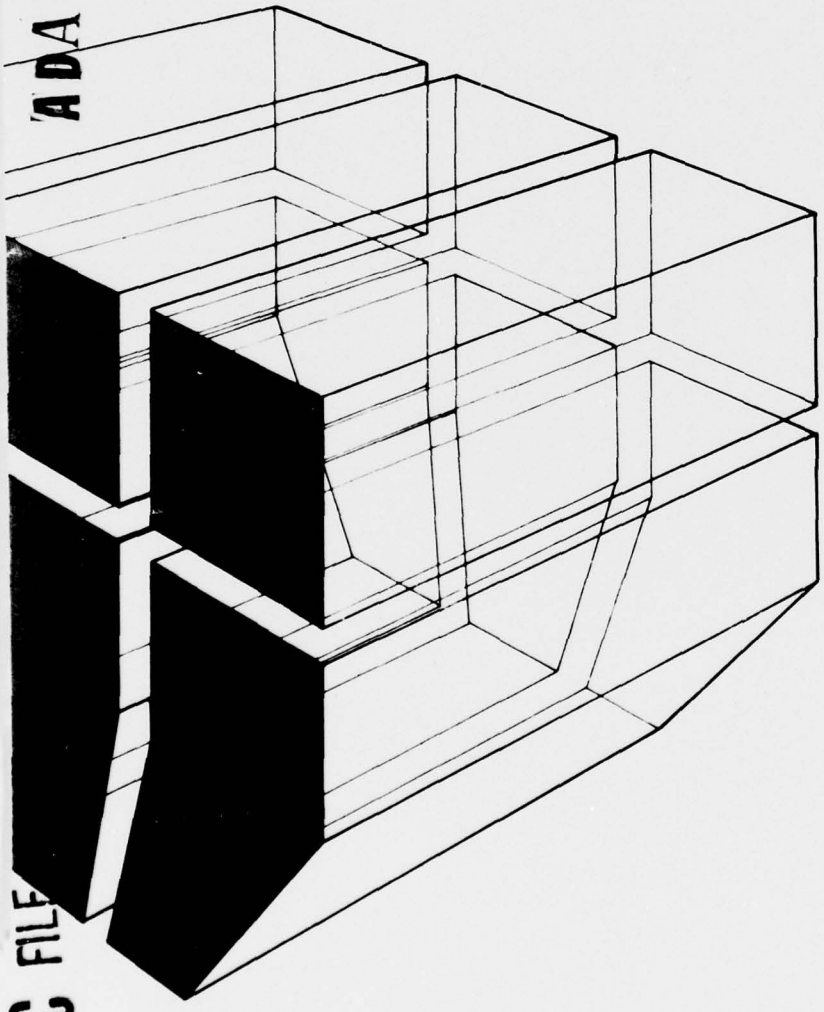
March 1977
Large Generator Set Test Procedure

STATIONARY DIESEL ENGINE-GENERATOR SET ACCEPTANCE TESTING PROCEDURES, METHODS, AND INSTRUCTIONS



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This Corps of Engineers (CE) Test Procedures document has been prepared in a format similar to the referenced MIL-STD-705B test methods to provide for easy implementation by CE district and division personnel. The procedures provide for acceptance testing large diesel engine-generator sets--up to 6000 kW capacity range--intended for installation in fixed military facilities as Class A (Prime), Class B (Standby), or Class C (Emergency) electrical power generation sources. → OVER

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

This document provides a list of MIL-STD-705B test methods which are directly applicable for acceptance testing large diesel engine-generator sets. In addition, the document provides new test procedures numbered CE-TP-1001 through 1004, designed specifically for acceptance testing large stationary diesel engine-generator sets intended for electrical power generation within fixed military facilities.

FOREWORD

This research was conducted for the Directorate of Military Construction, Office of the Chief of Engineers (OCE) under Project 4A7-63734DT08, "Military Construction Engineering"; Task 04, "Engineer Energy Development"; Work Unit 001, "Large Generator Set Procedures." The study was conducted by the Electromechanical Branch (EPM), Energy and Power Division (EP), Construction Engineering Research Laboratory (CERL), Champaign, IL. The OCE Technical Monitor for this study was Mr. S. Berkowitz. The CERL Principal Investigator was Mr. E. M. Takemori (EPM).

Appreciation is expressed to the Savannah District (South Atlantic Division), the Huntsville Division, and the Omaha District (Missouri River Division) of the Corps of Engineers and to the numerous diesel engine, generator, and diesel engine-generator set manufacturers for their contributions to the project.

COL J. E. Hays is Commander and Director of CERL and Dr. L. R. Shaffer is Technical Director. Mr. R. G. Donaghy is the Chief of EP and Mr. M. J. Pollock is the Chief of EPM.

CONTENTS

STATIONARY DIESEL ENGINE-GENERATOR SET ACCEPTANCE TESTING PROCEDURES, METHODS, AND INSTRUCTIONS

1 INTRODUCTION

Purpose

This document is intended to explain, establish, and standardize specific methods for obtaining measurements needed to test and evaluate the performance of large diesel engine-generator sets and related components intended for stationary electric power generation service--Class A (Prime), Class B (Standby), or Class C (Emergency)--within fixed military facilities. This document is to be used to determine compliance with requirements presented by procurement documents; it does not establish failure criteria. Specific Corps of Engineers Test Procedures and a list of applicable MIL-STD-705B[1] test methods are included. The terminology, instrumentation, general methods of measurement, and informative electrical technology are contained in MIL-HDBK-705B.[2]

Scope

This document is closely allied with MIL-STD-705B and MIL-HDBK-705B and references to both are freely used. Specification writers and equipment inspectors will find they need this document as well as MIL-STD-705B and MIL-HDBK-705B for acceptance testing large diesel engine-generator sets and their components. Due to the complexity of the requirements specified in purchase documents covering large diesel engine-generator sets and their components, the proper use of this document through referencing the applicable test methods will greatly simplify the preparation of specifications and expedite the purchase and acceptance of large diesel engine-generator sets. The purchase document requirements paragraph, included as the final paragraph of each test method, indicates the data required for the purchase description.

Copies of specifications, standards, and handbooks required by the contractor in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.

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[1] *Generator Sets, Engine-Driven, Methods of Tests and Instructions*, MIL-STD-705B (Department of Defense, June 1972).

[2] *Generator Sets, Electrical, Measurements and Instrumentations*, MIL-HDBK-705B (Department of Defense, June 1972).

This document provides test procedures numbered CE-TP-1001 through 1004, which have been prepared especially for acceptance testing large stationary diesel engine-generator sets for operation in fixed military facilities.

Numbering System

The methods are designated by numbers assigned in accordance with the following system. The methods included in this document are Corps of Engineers Test Procedures CE-TP-1001 through 1004. The decimal system is used to provide a means of readily identifying main and subparagraphs for reference purposes.

Method of Reference

Test methods contained in this standard shall be referenced, when applicable, in individual procurement documents by specifying this document and the method number. Equipment specifications will give specific requirements for test and limiting values.

2 LIST OF APPLICABLE MIL-STD-705B TEST METHODS

Method No.	Method
301.1b	Insulation Resistance Test
302.1a	High Potential Test
401.1a	Winding Resistance Test
410.1a	Open Circuit Saturation Curve Test
411.1a	Synchronous Impedance Curve Test (Short-Circuit Saturation Curve)
412.1a	Zero Power Factor Saturation Curve Test
413.1a	Rated Load Current Saturation Curve Test
415.0a	Summation of Losses Test
420.1a	Short-Circuit Ratio Test
421.1a	Direct-Axis Synchronous Reactance Test
422.1a	Negative-Sequence Reactance and Impedance Test
423.1a	Zero-Sequence Reactance Test
424.1a	Quadrature-Axis Synchronous Reactance Test
425.1a	Direct-Axis Transient Reactance Test
426.1a	Direct-Axis Subtransient Reactance Test
427.1a	Direct-Axis Transient Short-Circuit Time Constant
428.1a	Direct-Axis Subtransient Short-Circuit Time Constant Test
430.1a	Direct-Axis Transient Open-Circuit Time
432.1a	Short-Circuit Time Constant of Armature Winding Calculation
504.2a	Torsiographing Tests
505.1a	Overspeed Test (Set)
505.2a	Overspeed Protective Device Test
505.3b	Overspeed Test (Generator Only)
507.1c	Phase Sequence Test (Rotation)
508.1c	Phase Balance Test (Voltage)
509.1a	Circulating Current Test
511.1c	Regulator Range Test
511.2b	Frequency Adjustment Range Test
512.1c	Circuit Interrupter Test (Short-Circuit
512.2c	Circuit Interrupter Test (Overload Current)
512.3c	Circuit Interrupter (Overvoltage and Undervoltage)
513.2	Indicating Instrument Test (Electrical)

Method No.	Method
515.1a	Low Oil Pressure Protective Device Test
515.2a	Overtemperature Protective Device Test
515.5	Low Fuel Protective Device Test
516.1	Controls Direction of Rotation
516.2	Reverse Power Protective Device Test
521.1	Paralleling Aid Device Test
601.1c	Voltage Waveform Test (Oscillographic)
601.4a	Voltage Waveform Test (Harmonic Analysis)
608.1a	Frequency and Voltage Regulation, Stability and Transient Response Test (Short Term)
608.2	Frequency and Voltage Stability Test (Long Term)
610.1a	Voltage and Frequency Droop Test
614.1a	Voltage and Frequency Regulation Test (for Generator Sets)
619.1c	Voltage Dip For Low Power Factor Load Test
619.2b	Voltage Dip and Rise For Rated Load Test
620.1a	Voltage Unbalance With Unbalanced Load Test (Line-to-Natural Load)
620.2a	Voltage Unbalance With Unbalanced Load Test (Line-to-Line)
625.1c	Short-Circuit Test (Mechanical Strength)
630.1c	Parallel Operation Test
652.1a	Shaft Current Test
670.1a	Fuel Consumption Test
680.1b	Temperature Rise Test (Generator Only)
680.2a	Temperature Rise Test (Alternate-Loading Method)
771.1	Load Bank Test

3 SPECIFIC CORPS OF ENGINEERS TEST PROCEDURES: CE-TP-1001 THROUGH 1004

Method CE-TP-1001

Start and Stop Test (Manual Operation)

1001.1 GENERAL. The adequacy of the starting, operating, and stopping instructions is essential to safe operation of the generator set. Any abnormal starting, operating, or stopping conditions may endanger personnel and/or equipment.

1001.2 APPARATUS. A stop watch shall be required.

1001.3 PROCEDURE. Using only the instructions and starting aids furnished with the generator set, perform the following operations:

NOTE: All starting demonstration tests shall be from specified cold ambient conditions. Cold ambient conditions shall be defined by the state of the engine coolant jacket water temperature.

(a) Start the engine generator set on command and record the total start-up time.

(1) Starting time shall be measured with a stopwatch.

(2) Total starting time shall be defined as the period from the time the command is given to initiate generator set start from complete rest, to the time the generator set has achieved 100 percent governed speed at a no-load condition.

(3) 100 percent governed speed shall be defined as the nominal engine speed to provide 60 Hz frequency from the generator.

(b) During starting operation, record any unusual vibrations or other irregularities which may reduce the reliability of the equipment or cause injury to the operating personnel.

(1) Unusual vibration shall be defined as visible or audible vibration of oil lines, intake and exhaust ducts, engine generator, engine wiring harness, fuel lines, coolant water lines, fans, turbocharger, etc.

(2) Other irregularities shall be defined as safety hazards to equipment and personnel--i.e., oil leaks, fuel leaks, coolant water leaks, hot gas leaks, inadequate safety shielding on rotating machinery and on high temperature exhaust lines.

(c) After achieving 100 percent governed speed, close generator set breaker to the load bus per furnished instructions. Check for correct phase connection of the generator to plant. Record any irregularities.

(d) Apply load in steps per furnished instructions. Record any unusual vibration or apparent irregularity which may reduce the reliability of the equipment or cause injury to the operating personnel.

(e) After achieving a 100 percent load factor, offload the generator set per furnished instructions. Record any unusual vibration or other apparent operational irregularity which may reduce the reliability of the equipment or cause injury to the operating personnel.

NOTE: All stopping demonstration tests shall be from 100 percent governed speed at no-load condition.

(f) Open generator breaker to feeder bus.

(g) Upon command, initiate stopping operation using furnished instruction. Record total stopping time.

(1) Stopping time shall be measured with a stopwatch.

(2) Total stopping time shall be defined as--from the time the command is given to initiate generator set stop from a 100 percent governed speed at no-load condition to the time the generator set has come to a complete rest.

(h) During stopping operation, record any unusual vibration or other irregularities which may reduce the reliability of the equipment or cause injury to the operating personnel.

(i) Repeat steps (a) through (h) twice.

NOTE: Prior to repeating the test, the engine coolant jacket water must be at cold start condition.

1001.4 RESULTS. The data sheet shall indicate how the set performed during this test, including the time to start, the operating time, the voltage and operating speed used during each period of operation, and the manner and time of set shutdown. Compare these results to the procurement document requirements.

d. Day tank.

1001.5 PROCUREMENT DOCUMENT REQUIREMENTS. The following items must be specified in the individual procurement document:

(a) The voltage connection and frequency at which this method is to be performed.

(b) Maximum allowable engine coolant jacket water temperature prior to starting.

(c) Procedure for starting, operating, and stopping the generator set.

(d) Starting aids to be furnished with the engine.

(e) Maximum total start-up time (seconds) for the generator set to reach 100 percent governed speed from a complete rest condition.

(f) Load application sequence as function of time.

(g) Maximum total stopping time (seconds) for the generator set to reach a complete rest condition from 100 percent governed speed (if applicable).

(h) Maximum number of start attempts allowed before engine is operational.

Method CE-TP-1002

Start and Stop Test (Automatic Operation)

1002.1 GENERAL. The adequacy of the starting and stopping instructions is essential to safe operation of the generator set. Any abnormal start and stop conditions may endanger personnel and/or equipment.

1002.2 APPARATUS. An oscillographic recorder capable of recording switch traces as well as analog voltages from frequency and voltage transducers. For stopping times, a stopwatch may be used in lieu of the oscillographic recorder.

1002.3 PROCEDURE. Using only the automatic starting and stopping aids furnished with the generator set, demonstrate the following capabilities:

NOTE: All starting demonstration tests shall be from specified cold ambient conditions. Cold ambient conditions shall be defined by the state of the engine coolant jacket water temperature.

(a) Start the generator set using the automatic start equipment. Start condition signaling shall be as specified by procurement specification.

NOTE: Total starting time shall be defined as the period from the time the automatic start equipment receives a start signal to the time the generator set is carrying the specified load and has achieved steady state loading as defined by nominal voltage and frequency (Figure 1001.1).

(b) The oscillographic recorder shall record the following:

(1) Total start time.

(2) Start signal.

(3) Load application signal.

(4) Voltage-AC.

(5) Frequency.

(c) During starting operation, record any unusual vibration or other irregularities which may reduce equipment reliability or injure operating personnel.

(1) Unusual vibration shall be defined as visible or audible vibration of oil lines, intake and

Typical Automatic Start Sequence Test

for Generator Set From Dead Stop

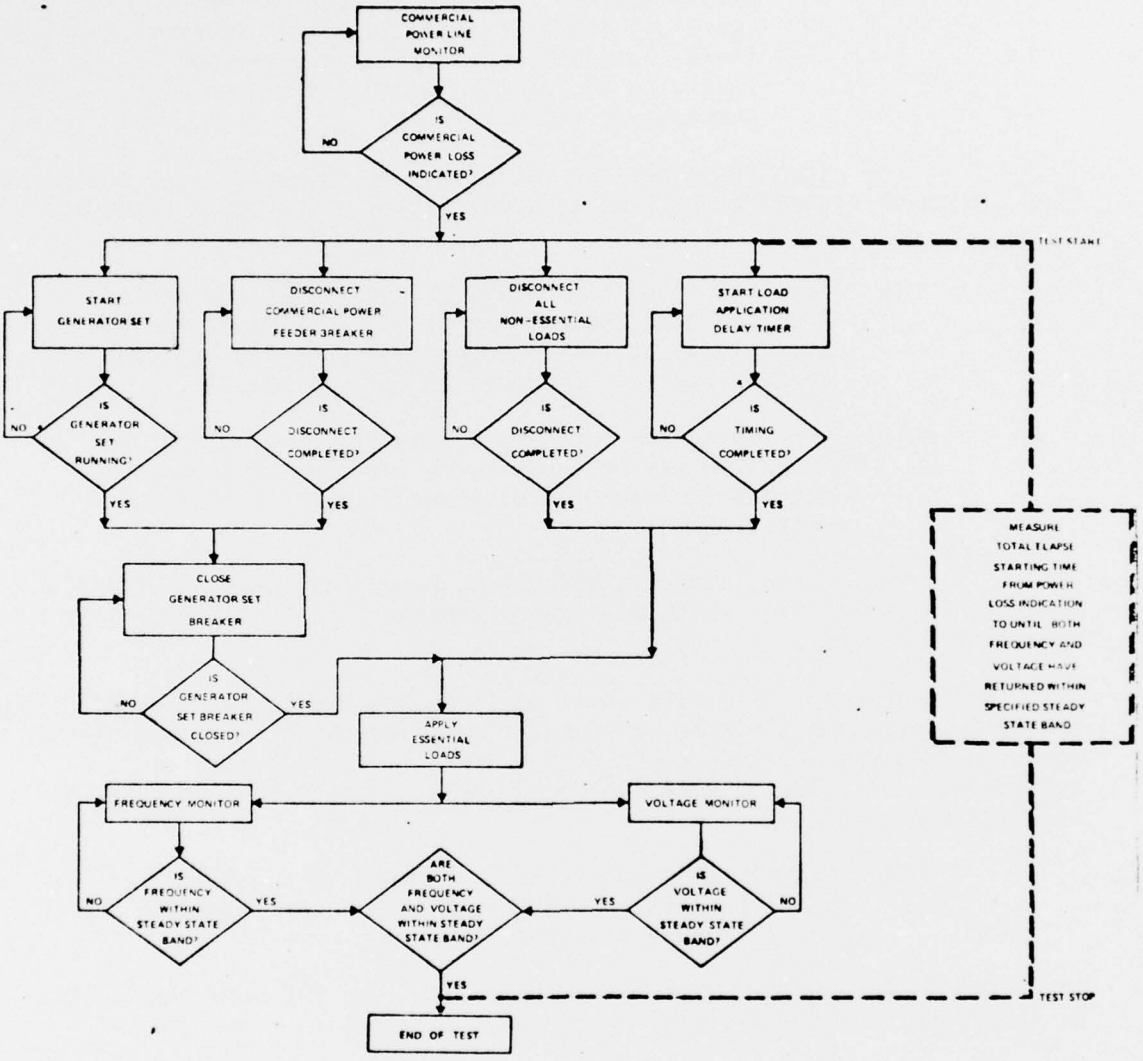

Figure 1001.1

exhaust ducts, engine generator set, engine wiring harness, fuel lines, coolant water lines, lubricating oil lines, fans, turbochargers, etc.

(2) Other irregularities shall be defined as safety hazards to equipment and personnel--i.e., oil leaks, fuel leaks, coolant water leaks, hot gas leaks, inadequate safety shielding on rotating machinery and on high temperature exhaust lines.

(d) Stop the generator set using the automatic stop equipment. Stop condition signaling shall be as specified by procurement specification.

NOTE: Total stopping time shall be defined as the period from the time the automatic stop equipment receives a stop signal to the time the generator set has come to complete rest (Figures 1001.2 and 1001.3).

NOTE: For timing the duration of the stopping period, a stopwatch may be substituted for the oscillographic recorder unless otherwise specified by the procurement document.

(e) During stopping operation, record any unusual vibration or other irregularities which may reduce equipment reliability or injure operating personnel.

1002.4 RESULTS. The data shall indicate how the set performed during the test, including the time to start, identification of starting signal, when the load was applied, elapsed time from the start signal to load application, and elapsed time from load application to achievement of steady state condition.

NOTE: Steady state condition is defined as the condition at which voltage and frequency have recovered to the allowable steady state band.

1002.5 PROCUREMENT DOCUMENT REQUIREMENTS. The following items must be specified in the individual procurement document:

(a) The nominal voltage and frequency at which this method is to be performed.

(b) Maximum allowable engine coolant jacket water temperature prior to starting.

TYPICAL AUTOMATIC SEQUENCE TO TRANSFER POWER SOURCE FROM GENERATOR SET TO COMMERCIAL FEEDER AND TO TERMINATE GENERATOR SET OPERATION

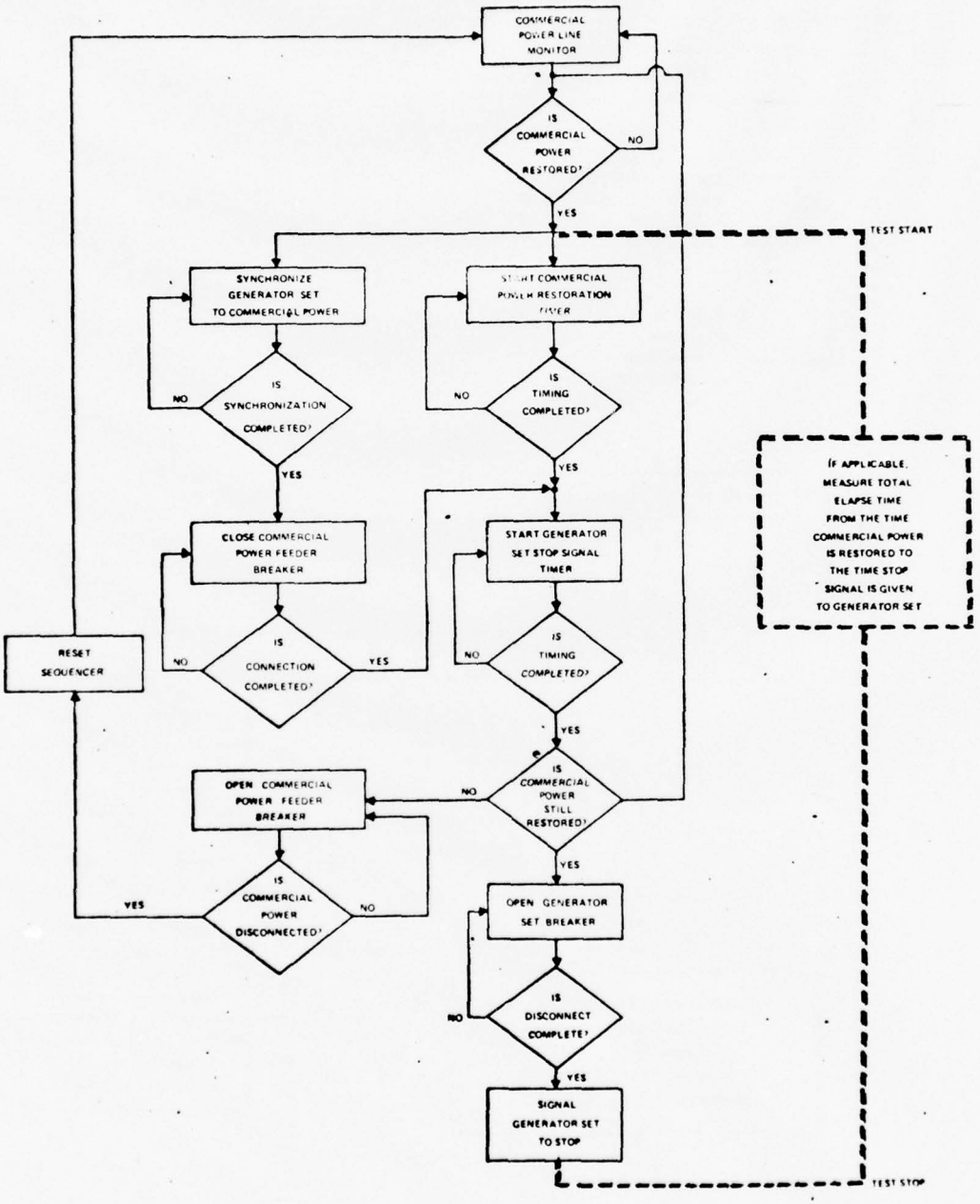

Figure 1001.2

TYPICAL AUTOMATIC STOPPING SEQUENCE FOR GENERATOR SET AFTER COMMERCIAL POWER HAS BEEN RESTORED

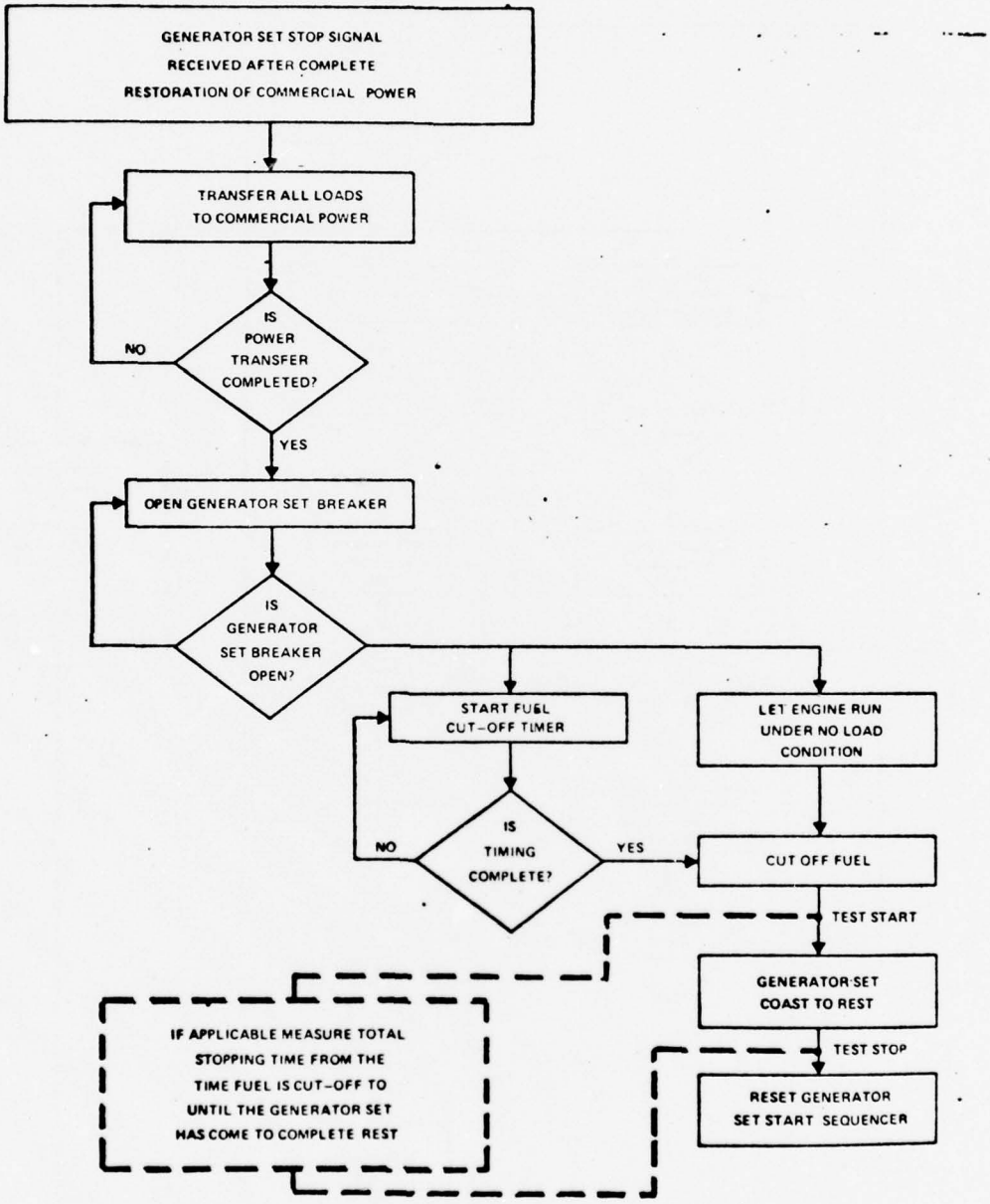

Figure 1001.3

(c) Sequential requirement for automatically starting, operating, and/or stopping the generator set.

(d) Starting aids to be furnished with the engine.

(e) Type(s) of signal(s) which will require the automatic start of the generator set.

(f) Maximum total start-up time (seconds) for the generator set to reach steady state condition from a complete rest condition after specified load is applied to the generator set during starting operation.

(g) Nominal load to be applied during starting operation.

(h) Maximum number of starts without failure.

(i) Type(s) of stopping signal(s).

(j) Maximum total stopping time (seconds) for the generator set to reach complete rest condition from steady state condition.

Method CE-TP-1003

Voltage Waveform (Oscilloscopic)

1003.1 GENERAL. In this test, photographs of the oscilloscope screen are taken to be used in determining the voltage waveform deviation factor instead of oscillograms, as described in MIL-STD-705 methods 601.1 and 601.2.

Load conditions under which the test shall be performed and permissible deviation factors are given in the procurement documents.

1003.2 APPARATUS. The same test apparatus is used for this test as for MIL-STD-705 method 601.1 except that an oscilloscope is substituted for the oscillograph.

1003.3 PROCEDURE.

(a) Preparation for test. Instrumentation for measuring load conditions shall be as described and illustrated in method 205.1, paragraph 205.1.10 of MIL-HDBK-705.

(b) Test.

(1) Operate the generator under speed and load conditions as required by the procurement documents. Repeat the remainder of this test procedure for each specified load condition.

(2) Adjust the amplitude of the voltage trace on the oscilloscope screen to at least 2 inches.

(3) Adjust the oscilloscope sweep circuit until the per-cycle time base is at least 3 inches.

(4) After the above conditions have been met, take a photograph of the oscilloscope screen, showing the voltage waveform.

(5) Disconnect the generator from the oscilloscope.

(6) Connect a source of pure sine wave voltage that has the same rms value and frequency as the generator voltage waveform to the oscilloscope.

NOTE: Care shall be exercised not to introduce any resistances or nonlinear current elements which will distort the voltage wave when adjusting the sine wave voltage rms value to the same as that of the generator.

(7) Take a photograph of the oscilloscope screen.

1003.4 RESULTS. The instructions for obtaining the results of this test are identical with those given in MIL-STD-705 method 601.1.

Method CE-TP-1004

Installation Checklist

1004.1 GENERAL. To insure that quality control surveillance has been maintained during installation of the generator sets and their appurtenance, a detailed checklist has been provided. This checklist can be modified as necessary to suit the respective installation.

1004.2 APPARATUS. None.

1004.3 PROCEDURE. Verify completion of the following quality control procedures to the satisfaction of the contracting officer before activating any systems.

(a) Engine fuel (diesel oil) system.

(1) Check for correct installation of the following:

a. Storage vessel(s).

b. Transfer equipments.

c. Loading/unloading dock equipment.

d. Day tank.

e. Piping.

(2) Check for completion of the following:

a. Cleaning of piping segments.

b. Pickling of piping segments.

c. Passivation of piping segments.

d. Hydrotesting of piping segments.

e. Dehydration of piping segments.

(3) Check for cleanliness of the following:

a. Storage vessel(s).

b. Transfer equipments.

c. Day tank.

d. Valves.

e. Check valves.

f. Safety relief valves and/or burst disc assembly.

g. Regulator valves.

h. Pressure gages.

i. Liquid level gages.

j. Temperature gage.

k. Filter assemblies and filters.

(4) Check for satisfactory completion of leak test. If air is used for leak testing, it must be free of moisture. Check for leaks either by visual method using liquid type leak detector solution--i.e., equivalent to LEAK TEC Formula Number 372B (American Gas and Chemicals, Inc., 511 East 72nd Street, New York, NY 10021)--or by pressure decay method.

(5) Check adjustment of the limit switches on the day tank to give the following:

a. Maximum liquid level switch to stop fuel transfer operation from the storage vessel to the day tank.

b. Minimum liquid level limit switch to start fuel transfer operation from storage vessel to day tank.

c. Low liquid level limit switch to signal safety shutdown of the diesel engine-generator set.

(6) Check operation of the storage tank.

a. Check adjustment of the safety valve setting set at ____ ± ____psig.

b. Check the blanket gaseous nitrogen purge pressure regulator setting, if applicable. Set at ____ ± ____psig.

c. Check the safety relief burst disc assembly for correct burst diaphragm installation. Diaphragm burst value = ____ ± ____psig.

d. Check closed storage vessel drain valve.

(7) Check operation of the loading/unloading dock, including:

a. Fuel trailer and/or tank car transfer valves.

b. Electrical grounding circuit.

c. Check for correct filter installation in the filter assembly.

(8) Check operation of the storage tank to day tank transfer equipments, including:

a. Transfer line shutoff valve.

b. Correct rotation of transfer pump.

NOTE: Do not run more than 5 minutes consecutively without liquid in the pump or pump shaft seal damage may occur.

c. Transfer line relief valve set at correct bypass pressure of ____ ± ____psig.

d. Transfer line drain valve.

e. Automatic transfer pump start/stop operation. Starting signal will come from the minimum day tank liquid level switch and the stopping signal will come from the maximum day tank liquid level switch.

f. Manual start/stop operation of the transfer pump using override switch.

g. Automatic transfer pump stop operation when the low liquid level switch is energized.

h. Correct filter installation in the transfer line.

(9) Check operation of the gravity-fed transfer line from the day tank to the engine, including:

a. Transfer line shutoff valve at tank outlet.

b. Transfer line shutoff valve at the diesel engine interface.

c. Correct filter installation in the filter assembly.

(b) Engine fuel (No. 6 fuel oil) system.

(1) Check for correct installation of the following:

a. Storage vessel(s).

b. Transfer equipments.

c. Storage vessel heater equipments (steam and/or (electric).

d. Day tank.

e. Day tank heater equipment (hot water, steam, and/or electric).

f. Piping.

g. Loading/unloading dock.

h. Valves.

i. Relief valves.

j. Burst disc assemblies.

k. Pressure regulating valves.

l. Filters and filter assemblies.

(2) Check for completion of the following:

a. Cleaning of the piping segments.

b. Pickling of the piping segments.

c. Passivation of the piping segments.

d. Hydrotesting of the piping segments.

e. Dehydration of the piping segments.

(3) Check for cleanliness of the following:

a. Storage vessel(s).

b. Transfer equipments.

c. Storage vessel heater equipments (hot water, steam, and/or electric).

d. Day tank.

e. Day tank heater equipment (hot water, steam, and/or electric).

f. Piping.

g. Loading/unloading dock.

h. Valves.

i. Relief valves.

j. Burst disc assemblies.

k. Pressure regulating valves.

l. Filters and filter assemblies.

m. Pressure gages.

n. Liquid level gages.

o. Liquid level switches.

(4) Check for satisfactory completion of leak test. If air is used for leak testing, it must be free of moisture. Check for leaks either by visual method using liquid type leak detector solution--i.e., equivalent to LEAK TEC Formula Number #372B (American Gas and Chemicals, Inc., 511 East 72nd Street, New York, NY 10021)--or by pressure decay method.

(5) Check adjustment of the limit switches on the day tank to give the following:

a. Maximum liquid level switch to stop fuel transfer operation from the storage vessel to the day tank.

b. Minimum liquid level limit switch to start fuel transfer operation from the storage vessel to the day tank.

c. Low liquid level limit switch to signal safety shutdown of the diesel engine-operator set and stop operation of the transfer pump.

(6) Check operation of the day tank and storage vessel heaters, including:

a. High limit temperature sensing switch. (Switch to give heater cutoff signal.)

b. Low limit temperature sensing switch. (Switch to give heater cutoff signal.)

c. Cold temperature sensing switch. With the cold temperature switch energized, check engine start sequence to prevent transfer of the engine from diesel oil operation to No. 6 fuel oil operation. Also with the switch energized, check to insure that fuel line transfer pumps do not start.

(7) Check operation of the loading/unloading dock heater, including:

a. High limit temperature sensing switch to cut off heater operation.

b. Low limit temperature sensing switch to start heater operation.

c. Cold temperature sensing switch. When switch is energized, servo-operated transfer valve at the loading dock should automatically close.

NOTE: Fuel trailers normally have heater supplied by the tractor towing the trailer; therefore, this requirement would not apply. Also, this requirement does not apply if the transfer operation is completely manual.

(8) Check operation of the storage tank.

a. Check adjustment of the safety relief valve setting set at ____ ± ____psig.

b. Check the blanket gaseous nitrogen purge pressure regulator setting, if applicable, set at ____ ± ____psig.

c. Check the safety relief burst disc assembly for correct burst diaphragm installation. Diaphragm burst value = ____ ± ____psig.

d. Check closed storage vessel drain valve.

(9) Check operation of the loading/unloading, including:

a. Fuel trailer and/or tank car electrical grounding circuits.

b. Fuel trailer and/or tank car transfer valves.

c. Correct filter installation in the filter assembly.

(10) Check operation of the storage tank to day tank transfer equipment, including:

NOTE: On dual-fueled engine, the diesel engine will be started and stopped on No. 2 diesel oil in addition to running on No. 6 fuel oil; therefore, there will be two day tanks supplying fuel to the engine. Check operation of the diesel fuel tank per section (a) above.

a. Transfer line shutoff valve.

b. Correct rotation of transfer pump.

NOTE: Do not run pump more than 5 consecutive minutes without liquid or pump shaft seal may be permanently damaged.

c. Check that transfer line relief valve is set at correct bypass pressure of ____ ± ____psig.

d. Check operation of transfer line drain valve.

e. Check automatic transfer pump start/stop operation. Starting signal will come from minimum day tank liquid level switch and stopping signal will come from maximum day tank liquid level switch.

f. Check manual/stop operation of transfer pump using override switch.

g. Check automatic transfer pump stop operation when low liquid level switch is energized.

h. Check that automatic or manual transfer pump start is inoperative when cold temperature switch in fuel line is activated.

i. Check for correct installation of filter in filter assembly.

(11) Check operation of the gravity-fed transfer line from day tank to engine, including:

a. Transfer line shutoff valve at day tank outlet.

b. Transfer line shutoff valve at diesel engine interface.

c. Transfer line jacket heater, if applicable.

d. No. 6/No. 2 fuel oil switching valve, if applicable.

(12) Check operation of No. 6 fuel oil heater in both storage vessels and day tank.

a. Hot-water-operated system.

1. Check for correct rotation of recirculation pump.

NOTE: Do not run pump more 5 consecutive minutes without liquid or pump shaft seal may be permanently damaged.

2. Check automatic start/stop capability of the recirculation pump on the storage vessel. The start/stop signal will be derived from the minimum/maximum temperature sensors in the storage vessel and day tank. Also check automatic stop interlock to preclude accidental overheating of the No. 6 fuel oil.

3. Check operation of the stirring motor in the storage tank and day tank.

b. Steam-operated system.

1. Check operation of the steam supply valve.

2. Check automatic operation of the servo-controlled supply valve. The opening/closing signal will be derived from the minimum/maximum temperature sensors in the storage and day tanks. Also check automatic close interlock to preclude accidental overheating of the No. 6 fuel oil.

3. Check operation of the stirring motor in the storage tank and day tank.

c. Electrically heated (resistance-type) system.

1. Check manual on/manual off operation of heater.

2. Check automatic on/off operation of heater. The on/off signal will be derived from the minimum/maximum temperature sensors in the storage and day tanks. Also check automatic off interlock to preclude accidental overheating of the No. 6 fuel oil.

3. Check operation of stirring motor in storage and day tanks.

(c) Engine fuel (natural gas) system.

(1) Check for correct installation of the following:

a. Accumulator.

b. Filter assembly.

c. Pressure regulating valve.

d. Main fuel line shutoff valve.

e. Pressure gages.

f. Flow-metering equipments.

g. Engine fuel line shutoff valve.

(2) Check for completion of the following:

a. Cleaning of piping segments.

b. Pickling of piping segments.

c. Passivation of piping segments.

d. Hydrotesting of piping segments.

e. Dehydration of piping segments.

(3) Check for cleanliness of the following:

a. Accumulator.

b. Filter assembly.

c. Pressure-regulating valve.

d. Main fuel line shutoff valve.

e. Pressure gages.

f. Flow-metering equipments.

g. Engine fuel line shutoff valve.

(4) Check for satisfactory completion of leak testing. If air is used for leak testing, it must be free of moisture. Check for leaks either by visual method using liquid type leak detector solution--i.e., equivalent to LEAK TEC Formula Number #372B (American Gas and Chemicals, Inc., 511 East 72nd Street, New York, NY 10021)--or by pressure decay method.

(5) Check adjustment on flow regulator to maintain correct manifold pressure to engine. Pressure set at ____ ± ____psig.

(6) Check adjustment on the pressure limit switches on the following:

a. Check operation of maximum pressure set point set at ____ ± ____psig. This switch is interlocked to the main fuel line shutoff valve and is used to prevent accidental overpressure to the diesel engine fuel manifold.

b. Check operation of minimum pressure set point set at ____ ± ____psig. This switch is interlocked with the automatic shutdown sequence of the diesel engine to prevent engine failure caused by low fuel rate condition.

(d) Engine lube oil system (if applicable).

(1) Check for correct installation of the following:

a. Storage tank.

b. Transfer equipment.

c. Loading/unloading dock equipment.

d. Piping.

e. Filter assembly.

(2) Check for completion of the following:

a. Cleaning of the piping segments.

b. Pickling of the piping segments.

c. Passivation of the piping segments.

d. Hydrotesting of the piping segments.

e. Dehydration of piping segments.

(3) Check for cleanliness of the following:

a. Storage tank.

b. Transfer equipment.

c. Loading/unloading dock equipment.

d. Pre-lubrication circulating pump assembly.

e. Filter assembly.

(4) Check for satisfactory completion of leak check. If air is used for leak testing, it must be free of moisture. Check for leaks either by visual method using liquid type leak detector solution--i.e., equivalent to LEAK TEC Formula Number #372B (American Gas and Chemicals, Inc., 511 East 72nd Street, New York, NY 10021)--or by pressure decay method as specified by the procurement document.

(5) Check adjustment of limit switches on engine lubricating oil sump tank.

a. Check set point of maximum liquid level switch. The set point will be the normal maximum oil level. The limit switch is used to shut off transfer pump and fill valve from the storage tank to engine sump tank.

b. Check set point of minimum liquid level switch. The set point will be the normal minimum oil level. The limit switch starts transfer pump operation and opens fill valve from the storage tank to engine sump tank.

c. Check set point of the overfill liquid level switch. The set point will be the highest oil level before engine sump overflows. The limit switch shuts off transfer pump and fill valve from the storage tank to the engine sump tank.

d. Check set point of underfill liquid level switch. The set point will be the lowest oil level before the engine sump becomes non-operational. The limit switch signals shutoff of the transfer pump and the fill valve and also signals diesel engine shutdown.

(6) Check operation of transfer system from lube oil storage tank to engine oil sump.

a. Check for correct rotation of engine pre-lube pump unit.

b. Check for correct rotation of lube oil storage tank to engine sump pump unit.

c. Check for pressure setting on engine pre-lube oil supply.

d. Check for correct pressure setting in transfer line from storage tank to engine sump.

e. Check for automatic start/stop of pre-lube pump. Start/stop signal will be derived from engine oil pressure switch.

f. Check for automatic start/stop of oil transfer pump. Start/stop signal will be derived from minimum/maximum liquid level switch.

g. Check for automatic stop of oil transfer pump and pre-lube pump and diesel engine. Stop signal to be derived from the underfill liquid level switch. Probable cause is broken oil line.

h. Check for automatic stop of oil transfer pump. Stop signal is to be derived from the overfill liquid level switch.

i. Check for manual start/stop operation of lube oil transfer pump.

j. Check for manual start/stop operation of engine prelubricating oil pump.

k. Check for correct installation of filter in oil filter assembly.

(e) Engine coolant system.

(1) Engine-mounted air-to-air radiator (if applicable).

a. Check for correct installation of radiator and hosing.

b. Test coolant system for visible water leakage at ____ ± ____psig.

c. Check for correct belt tension on engine fan drive.

d. Check for correct belt tension on engine water pump drive unit.

e. Check that coolant is filled to proper level with coolant types as specified by the procurement document.

f. Check high temperature engine cutoff switch circuit. This circuit signals diesel engine stop.

(2) Ground-mounted air-to-air radiator (if applicable).

a. Check for correct installation of radiator, piping segments, and hose.

b. Test coolant system for visible water leakage at ____ ± ____psig.

c. Check for correct belt tension (if applicable) on fan drive unit.

d. Check for correct fan drive motor rotation.

e. Check for correct belt tension (if applicable) on circulating coolant pump.

f. Check for correct circulating coolant pump motor rotation.

g. Check that coolant is filled to proper level with coolant type as specified by the procurement document.

h. Check for manual start/stop of circulating coolant pump motor.

i. Check for manual start/stop of fan drive motor.

j. Check for automatic start/stop of fan drive motor. Start/stop signal is derived from the maximum/minimum coolant temperature.

(3) Ground-mounted air to water cooling tower.

a. Check for correct installation of cooling tower, piping, and couplings.

b. Test cooling system for visible water leakage at ____ ± ____psig.

c. Check for correct belt tension (if applicable) on fan drive unit.

d. Check for correct fan drive motor rotation.

e. Check for correct belt tension (if applicable) on the coolant circulating pump.

f. Check for correct coolant circulating pump motor rotation.

g. Check for correct installation of make-up water system.

h. Check for correct operation of make-up water system. If system is automatic, test automatic fill/stop provision. The fill/stop signal will be derived from cooling tower sump minimum/maximum liquid level switch.

i. Check for correct operation of cooling tower sump overfill cutoff switch. The energized switch serves to terminate make-up water operation. This provision is to prevent accidental flooding.

j. Check for correct operation of cooling tower sump low level cutoff switch. The energized switch terminates make-up water fill and signals automatic stop of diesel engine and circulating pump. The probable cause of failure is a leaking coolant system--i.e., broken coupling or hose.

1004.4 RESULTS. None.

1004.5 PROCUREMENT DOCUMENT REQUIREMENT. None.

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